IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: **Navratil et al.**	§	
	§	Group Art Unit: **2626**
Serial No. **10/601,365**	§	
	§	Examiner: **Jackson, Jakieda R.**
Filed: **June 23, 2003**	§	
	§	
For: **Method and Apparatus to Compensate for Fundamental Frequency Changes and Artifacts and Reduce Sensitivity to Pitch Information in a Frame-Based Speech Processing System**	§	
	§	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

35526
PATENT TRADEMARK OFFICE
CUSTOMER NUMBER

APPEAL BRIEF (37 C.F.R. 41.37)

This brief is in furtherance of the Notice of Appeal, filed in this case on October 27, 2006.

A fee of $500.00 is required for filing an Appeal Brief. Please charge this fee to IBM Corporation Deposit Account No. 50-0510. No additional fees are believed to be necessary. If, however, any additional fees are required, I authorize the Commissioner to charge these fees which may be required to IBM Corporation Deposit Account No. 50-0510. No extension of time is believed to be necessary. If, however, an extension of time is required, the extension is requested, and I authorize the Commissioner to charge any fees for this extension to IBM Corporation Deposit Account No. 50-0510.

REAL PARTY IN INTEREST

The real party in interest in this appeal is the following party: International Business Machines Corporation of Armonk, New York.

RELATED APPEALS AND INTERFERENCES

With respect to other appeals or interferences that will directly affect, or be directly affected by, or have a bearing on the Board's decision in the pending appeal, there are no such appeals or interferences.

STATUS OF CLAIMS

A. TOTAL NUMBER OF CLAIMS IN APPLICATION

Claims in the application are: 1-30

B. STATUS OF ALL THE CLAIMS IN APPLICATION

1. Claims canceled: NONE
2. Claims withdrawn from consideration but not canceled: NONE
3. Claims pending: 1-30
4. Claims allowed: NONE
5. Claims rejected: 1-30
6. Claims objected to: NONE

C. CLAIMS ON APPEAL

The claims on appeal are: 1-30

STATUS OF AMENDMENTS

A Response to Final Office Action was not filed. Accordingly, the claims on appeal herein are as finally rejected in the Final Office Action dated September 21, 2006.

SUMMARY OF CLAIMED SUBJECT MATTER

A. CLAIM 1 - INDEPENDENT

The subject matter of claim 1 is generally directed to a method for speech processing. A frame of a first speech signal (**400**, **Figure 4**, also see page 10, lines 18-19) is filtered to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples (**402**, **404**, **Figure 4**, also see page 10, lines 19-26). At least one pitch cycle within the residual frame is determined from the residual signal frame (**406**, **Figure 4**, also see page 11, lines 8-10) and a transformation function is applied to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles (**408**, **Figure 4**, also see page 11, lines 11-18). A second speech signal is synthesized from the modified residual frame and the set of vocal tract model parameters, whereby the second speech signal is a pitch-compensated speech signal (**410**, **412**, **Figure 4**, also see page 13, line 23-page 14, line 11).

B. CLAIM 11 – INDEPENDENT

The subject matter of claim 11 is generally directed to a computer program product in a computer readable medium for speech processing. The computer program product includes functional descriptive material that, when executed by a computer, causes the computer to perform acts that include filtering a frame of a first speech signal (**400**, **Figure 4**, also see page 10, lines 18-19) to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples (**402**, **404**, **Figure 4**, also see page 10, lines 19-26). At least one pitch cycle within the residual frame is determined from the residual signal frame (**406**, **Figure 4**, also see page 11, lines 8-10), and a transformation function is applied to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles (**408**, **Figure 4**, also see page 11, lines 11-18). A second speech signal is synthesized from the modified residual frame and the set of vocal tract model parameters, whereby the

second speech signal is a pitch-compensated speech signal (**410**, **412**, **Figure 4**, also see page 13, line 23-page 14, line 11).

C. CLAIM 21 – INDEPENDENT

The subject matter of claim 21 is generally directed to a data processing system for speech processing. Means are provided for filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples (processor **202**, **Figure 2**, page 8, lines 16-19, also see **402**, **404**, **Figure 4**, page 10, lines 19-26). Means are provided for determining from the residual signal frame at least one pitch cycle within the residual frame (processor **202**, **Figure 2**, page 8, lines 16-19, also see **406**, **Figure 4**, page 11, lines 8-10, and means are also provided for applying a transformation function to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles (processor **202**, **Figure 2**, page 8, lines 16-19, also see **408**, **Figure 4**, page 11, lines 11-18). Means are provided for synthesizing a second speech signal from the modified residual frame and the set of vocal tract model parameters, whereby the second speech signal is a pitch-compensated speech signal (processor **202**, **Figure 2**, page 8, lines 16-19, also see **410**, **412**, **Figure 4**, page 13, line 23-page 14, line 11).

D. CLAIM 5 – DEPENDENT

The subject matter of claim 5, which depends from claim 4, specifies that the transformation function changes the time scale of the residual signal by performing certain operations. The operations include selecting a set of samples from the residual signal, wherein the set of samples is a consecutive sequence of samples taken from the residual signal, such that the set of samples corresponds to a contiguous interval of time in the residual signal (signals **600A**, **Figure 6A**, also see page 11, lines 22-25). Linear interpolation is performed between samples in the first set of samples so as to model the residual signal over the contiguous interval of time as a piecewise linear function, and the modified residual signal is generated by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new

sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame (signals **602A**, **Figure 6A**, also see page 11, line 25-page 12, line 2).

E. CLAIM 15 – DEPENDENT

The subject matter of claim 15, which depends from claim 14, specifies that the transformation function changes the time scale of the residual signal by performing certain operations. The operations include selecting a set of samples from the residual signal, wherein the set of samples is a consecutive sequence of samples taken from the residual signal, such that the set of samples corresponds to a contiguous interval of time in the residual signal (signals **600A**, **Figure 6A**, also see page 11, lines 22-25). Linear interpolation is performed between samples in the first set of samples so as to model the residual signal over the contiguous interval of time as a piecewise linear function, and the modified residual signal is generated by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame (signals **602A**, **Figure 6A**, also see page 11, line 25-page 12, line 2).

F. CLAIM 25 – DEPENDENT

The subject matter of claim 25, which depends from claim 24, specifies that the transformation function changes the time scale of the residual signal by performing certain operations. The operations include selecting a set of samples from the residual signal, wherein the set of samples is a consecutive sequence of samples taken from the residual signal, such that the set of samples corresponds to a contiguous interval of time in the residual signal (processor **202**, **Figure 2**, page 8, lines 16-19, also see signals **600A**, **Figure 6A**, page 11, lines 22-25). Linear interpolation is performed between samples in the first set of samples so as to model the residual signal over the contiguous interval of time as a piecewise linear function, and the modified residual signal is generated by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame (processor **202**, **Figure 2**, page 8, lines 16-19, also see signals **602A**, **Figure 6A**, page 11, line 25-page 12, line 2).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The grounds of rejection to review on appeal are as follows:

A. GROUND OF REJECTION 1 (Claims 1-4, 8, 11-14, 18, 21-24 and 28)

Claims 1-4, 8, 11-14, 18, 21-24 and 28 are rejected under 35 U.S.C. § 102(b) as being anticipated by Lowry (U.S. Patent No. 5,787,398).

B. GROUND OF REJECTION 2 (Claims 6, 7, 10, 16, 17, 20, 26, 27 and 30)

Claims 6, 7, 10, 16, 17, 20, 26, 27 and 30 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Lowry (U.S. Patent No. 5,787,398) in view of Chuang (U.S. Patent No. 4,941,178).

C. GROUND OF REJECTION 3 (Claims 9, 19 and 29)

Claims 9, 19 and 29 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Lowry (U.S. Patent No. 5,787,398) in view of Moriya et al. (U.S. Patent No. 5,651,090).

D. GROUND OF REJECTION 4 (Claims 5, 15 and 25)

Claims 5, 15 and 25 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Lowry (U.S. Patent No. 5,787,398) in view of Laroia et al. (U.S. Patent No. 5,839,098).

ARGUMENT

A. GROUND OF REJECTION 1 (Claims 1-4, 8, 11-14, 18, 21-24 and 28)

Claims 1-4, 8, 11-14, 18, 21-24 and 28 are rejected under 35 U.S.C. § 102(b) as being anticipated by Lowry (U.S. Patent No. 5,787,398).

Embodiments of the present invention are generally related to a mechanism for providing a synthesized speech signal that compensates for variations in a speaker's pitch so that the speech can be more accurately recognized by a speech recognition system. Lowry, on the other hand, relates to speech generation and describes a mechanism to introduce pitch variations into generated speech to make it sound more natural. In finally rejecting the claims as being anticipated by Lowry, the Examiner states:

> Regarding **claims 1, 11 and 21**, Lowry discloses a method, computer program product and a data processing system, hereinafter referenced as a method comprising:
>
> filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters (vocal tract components of a waveform; column 3, lines 8-22), wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples (inherent in LPC processing);
>
> determining from the residual signal frame at least one pitch cycle within the residual frame (at least two per pitch period; column 3, lines 25-35);
>
> applying a transformation function (temporal spacing) to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles (re-form the desired speech signal; column 3, lines 36-51); and
>
> synthesizing a second speech signal from the modified residual frame and the set of vocal tract model parameters (modified pitchmark to resynthesize speech from the residual; column 5, lines 2-6), whereby the second speech signal is a pitch-compensated speech signal (to give more consistent results; column 5, lines 24-35 and column 6, lines 15-25).

Final Office Action dated September 21, 2006, page 3.

Independent claim 1 on appeal herein is as follows:

> 1. A method comprising:
>
> filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples;
>
> determining from the residual signal frame at least one pitch cycle within the residual frame;
>
> applying a transformation function to the residual frame to obtain a modified

residual frame, wherein the modified residual frame contains an integer number of pitch cycles; and

synthesizing a second speech signal from the modified residual frame and the set of vocal tract model parameters, whereby the second speech signal is a pitch-compensated speech signal.

A prior art reference anticipates the claimed invention under 35 U.S.C. § 102 only if every element of a claimed invention is identically shown in that single reference, arranged as they are in the claims. *In re Bond*, 910 F.2d 831, 832, 15 U.S.P.Q.2d 1566, 1567 (Fed. Cir. 1990). All limitations of the claimed invention must be considered when determining patentability. *In re Lowry*, 32 F.3d 1579, 1582, 32 U.S.P.Q.2d 1031, 1034 (Fed. Cir. 1994). Anticipation focuses on whether a claim reads on the product or process a prior art reference discloses, not on what the reference broadly teaches. *Kalman v. Kimberly-Clark Corp.,* 713 F.2d 760, 218 U.S.P.Q. 781 (Fed. Cir. 1983).

With respect to claim 1, Lowry does not disclose or suggest "filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples" and also does not disclose or suggest "applying a transformation function to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles"; and, accordingly, does not anticipate claim 1.

In particular, with respect to the claim limitation of "filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, <u>wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples</u>." (emphasis added), the Examiner asserts that this limitation is "inherent in LPC processing." More specifically, the Examiner states:

> Lawry teaches that the LPC analysis may be performed using any of the conventional methods. The speech signal and residual signal containing a same fixed number of samples is an inherent, standard feature that is old and well know in the art of LPC processing (column 5, lines 13-21). Some examples of this inherent feature is demonstrated in Thomas et al. (Figures 5.4) and Markel et al. (equation 1.12).

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Column 5, lines 13-21 of Lowry, referred to by the Examiner in the above statement is as follows:

> The LPC analysis may be performed using any of the conventional methods, when using covariance or stabilized covariance method, each set of LPC parameters would be obtained for a section of the speech portion (analysis frame) of length equal to the pitch period (centered on the midpoint of the pitch period rather than on the pitch mark), or alternatively longer, overlapping sections might be used which has the advantage of permitting the use of an analysis frame of fixed length according to pitch.

The above recitation in Lowry does not teach or suggest "wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples." Instead the passage teaches use of an analysis frame that is of fixed length. However, a fixed length analysis frame is not the same thing as the frame of a first speech signal and a residual signal frame containing a same fixed number of samples. Instead the passage merely teaches that the analysis frame alone is of a fixed length. The above cited passage of Lowry does not teach that residual frame contains the same fixed number of samples as the frame of the first speech signal.

Appellants also respectfully disagree with the Examiner's assertion that the claimed feature of "filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples" is inherent in LPC processing and, hence, apparently inherently disclosed in Lowry. The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic *In re Rijckaert*, 9 F.3d 1532, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'" *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999).

As demonstrated above, Lowry does not disclose "filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples", nor has the Examiner provided extrinsic evidence making it clear that the missing subject matter is necessarily present in Lowry or otherwise fulfilled the burden of establishing inherency.

Lowry also does not disclose or suggest "applying a transformation function to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles" as recited in claim 1. The Examiner refers to column 3, lines 36-51 of Lowry, reproduced below, as teaching this feature:

> When raising the pitch, the windowed segments are added together, but with a reduced temporal spacing, as shown in FIG. 3a; if the pitch is lowered, the temporal spacing is increased. In either case, the relative window widths are chosen to give overlap of the sloping flanks (i.e. 50% overlap on the intermediate windows) during synthesis to ensure the correct signal amplitude. The temporal adjustment is controlled by the signals PP. Typical widths for the intermediate windows are 2 ms whilst the width of the windows located on the pitch marks will depend on the pitch period of the particular signal but is likely to be in the range 2 to 10 ms. The use of multiple windows is thought to reduce phase distortion compared with the use of one window per pitch period. After the temporal processing, the residual is passed to an LPC filter **105** to re-form the desired speech signal.

The above cited passage of Lowry does not appear to anywhere disclose the claimed feature of "applying a transformation function to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles." While the above cited passage may teach modifying a residual frame, nowhere does the passage appear to specifically teach "wherein the modified residual frame contains an integer number of pitch cycles."

For at least the above reasons, Lowry does not teach each and every feature of claim 1, and does not anticipate claim 1. Claim 1, accordingly, patentably distinguishes over Lowry in its present form.

Independent claims 11 and 21 recite similar subject matter as claim 1 and are also not anticipated by Lowry for similar reasons as discussed above with respect to claim 1. Claims 2-4, 8, 12-14, 18, 22-24, and 28 are dependent claims, depending from independent claims 1, 11, and 21, and are also not anticipated by Lowry, at least by virtue of their dependency.

Therefore, claims 1-4, 8, 11-14, 18, 21-24 and 28 are not anticipated by Lowry, and it is respectfully requested that the Board reverse the Examiner's Final Rejection of those claims.

B. GROUND OF REJECTION 2 (Claims 6, 7, 10, 16, 17, 20, 26, 27 and 30)

Claims 6, 7, 10, 16, 17, 20, 26, 27 and 30 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Lowry (U.S. Patent No. 5,787,398) in view of Chuang (U.S. Patent No. 4,941,178).

In rejecting the claims, the Examiner acknowledges that Lowry does not specifically teach "wherein the transformation function changes the time scale of the residual signal by performing a non-linear time warping operation on an interval of the residual signal so as to find a correspondence between samples from the interval of the residual signal and samples in a reference signal", and cites Chuang as disclosing "speech recognition using preclassification and spectral normalization wherein the transformation function changes the time scale of the residual signal by performing a non-linear time warping operation...".

Claims 6, 7, 10, 16, 17, 20, 26, 27 and 30, however, depend from and further restrict one of independent claims 1, 11 and 21. Chuang does not supply the deficiencies in Lowry as described in detail above. Claims 6, 7, 10, 16, 17, 20, 26, 27 and 30, accordingly, are not obvious over Lowry in view of Chuang, at least by virtue of their dependency.

Therefore, claims 6, 7, 10, 16, 17, 20, 26, 27 and 30 are not obvious over Lowry in view of Chuang, and it is respectfully requested that the Board reverse the Examiner's Final Rejection of those claims.

C. GROUND OF REJECTION 3 (Claims 9, 19 and 29)

Claims 9, 19 and 29 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Lowry (U.S. Patent No. 5,787,398) in view of Moriya et al. (U.S. Patent No. 5,651,090).

In rejecting the claims, the Examiner acknowledges that Lowry does not specifically teach a method comprising "cyclically shifting samples in the modified residual signal frame so as to normalize a phase of the modified residual signal frame", and cites Moriya et al. (hereinafter "Moriya") as teaching "a coding method wherein it comprises cyclically shifting samples in the modified residual signal frame so as to normalize a phase of the modified residual signal frame (normalized residual coefficients are cyclically shifted (column 19, lines 1 - 15), to suppress a pitch component."

Claims 9, 19 and 29, however, depend from independent claims 1, 11 and 21, respectively. Moriya does not supply the deficiencies in Lowry as described in detail above.

Claims 9, 19 and 29, accordingly, are not obvious over Lowry in view of Moriya, at least by virtue of their dependency.

Therefore, claims 9, 19 and 29 are not obvious over Lowry in view of Mariya, and it is respectfully requested that the Board reverse the Examiner's Final Rejection of those claims.

D. GROUND OF REJECTION 4 (Claims 5, 15 and 25)

Claims 5, 15 and 25 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Lowry (U.S. Patent No. 5,787,398) in view of Laroia et al. (U.S. Patent No. 5,839,098).

Claims 5, 15 and 25 depend from and further restrict claims 1, 11 and 21, respectively. Laroia does not supply the deficiencies in Lowry as described in detail above. Claims 5, 15 and 25, accordingly, are not obvious over Lowry in view of Moriya, at least by virtue of their dependency.

In addition, Appellants respectfully submit that claims 5, 15 and 25 patentably distinguish over Lowry in view of Laroia in their own right as well as by virtue of their dependency.

In particular, in rejecting the claims, the Examiner acknowledges that Lowry does not specifically teach "performing linear interpolation between samples in the first set of samples so as to model the residual signal over said contiguous interval of time as a piecewise linear function and generating the modified residual signal by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame", but cites Laroia et al. (hereinafter "Laroia") as supplying the deficiencies in Lowry. Specifically, the Examiner states:

> Laroia discloses a method to identify pitch pulses (column 7, lines 13-22) by performing linear interpolation between samples in the first set of samples (linear interpolation; column 9, lines 4-16) so as to model the residual signal over said contiguous interval of time as a piecewise linear function (piecewise linear function; column 9, lines 38-43); and
>
> generating the modified residual signal by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples (frames of fixed numbers) as contained in the residual signal frame (column 6, lines 25-62), to improving speech.
>
> Therefore, it would have been obvious to one ordinary skilled in the art at the time the invention was made to modify Lowry's method wherein it performs linear interpolation between samples in the first set of samples so as to model the

> residual signal over said contiguous interval of time as a piecewise linear function and generates the modified residual signal by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame, as taught by Laroia, to enhance the characterization for producing an improved perceptual accuracy in corresponding synthesized speech (column 4, lines 14-18).

Final Office Action dated September 21, 2006, pages 8-9.

Claim 5 depends from claim 4 and is as follows:

> 5. The method of claim 4, wherein the transformation function changes the time scale of the residual signal by performing operations that include:
>
> selecting a set of samples from the residual signal, wherein the set of samples is a consecutive sequence of samples taken from the residual signal, such that the set of samples corresponds to a contiguous interval of time in the residual signal;
>
> performing linear interpolation between samples in the first set of samples so as to model the residual signal over said contiguous interval of time as a piecewise linear function; and
>
> generating the modified residual signal by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame.

Appellants respectfully disagree that Laroia discloses or suggests "generating the modified residual signal by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame." The Examiner refers specifically to column 9, lines 25-62 of Laroia as disclosing this feature. Column 6, lines 25-62 of Laroia is reproduced below for the convenience of the Board:

> An exemplary configuration for the short-term frequency spectrum processor **20** according to the invention is shown in FIG. **2**. Referring to FIG. **2**, the received digitized speech S(n) is divided into frames of a fixed number N of digital values by a partitioner **40**. The N digital values for S(nj+i), i=1,2, . . . , N, for j-th frame to be processed are provided to a pitch detector **50** and a window processor **55**. The use of the previously described non-overlapping frame intervals are for illustration purposes only and it should be readily understood that overlapping frame intervals are also useable in accordance with the invention.
>
> The pitch detector **50** determines if a voiced component is represented in the frame of the speech signal, or if the frame contain entirely unvoiced speech. If the detector **50** detects a voiced speech component, it determines the corresponding pitch period. A pitch period indicates the number of digitized samples in one cycle of the substantially periodic the voiced speech signal. Typically, a pitch period possesses a

> duration on the order of 3 msec. to 20 msec., which corresponds to 24 to 160 digital samples based on a sampling rate of 8.0 kHz.
>
> Exemplary methods for determining if a frame contains a voiced speech component and for identifying pitch period intervals are described in the previously cited Digital Processing of Speech Signals book, sects. 4.8, 7.2, 8.10.1, pp. 150-157, 372-378, 447-450. It is possible to determine a pitch period interval by examining the long-term correlation in the speech frame and/or by performing linear predictive analysis on the speech frame and identifying the location of pitch impulse in the resulting prediction residual. The pitch detector **50** also determines the gain constant G based on the energy of the of the samples comprising the frame sequence being processed. Methods for such a determination is not critical to practicing the invention. An exemplary method for determining the gain constant G is also described in the previously cited Digital Processing of Speech Signals book, sect. 8.2, pp. 404-407.

Nowhere in the above recitation is it disclosed or suggested that a modified residual signal is generated "by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame." Furthermore, neither Lawry nor Laroia contains any teaching or suggestion to combine the references in the manner proposed by the Examiner. Only the present application contains such a teaching. Appellants, accordingly, respectfully submit that the Examiner is using hindsight based on Appellants' own disclosure in combining Lowry and Laroia in an effort to achieve the present invention as recited in claim 5.

Claim 5, accordingly, patentably distinguishes over Lowry in view of Laroia in its own right as well as by virtue of its dependency from claim 1.

Claims 15 and 25 recite similar subject matter as claim 5, and also patentably distinguish over Lowry in view of Laroia.

Therefore, claims 5, 15 and 25 are not obvious over Lowry in view of Laroia, and it is respectfully requested that the Board reverse the Examiner's Final Rejection of those claims.

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CLAIMS APPENDIX

The text of the claims involved in the appeal are:

1. A method comprising:

filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples;

determining from the residual signal frame at least one pitch cycle within the residual frame;

applying a transformation function to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles; and

synthesizing a second speech signal from the modified residual frame and the set of vocal tract model parameters, whereby the second speech signal is a pitch-compensated speech signal.

2. The method of claim 1, wherein the integer number of pitch cycles is a predetermined integer number of pitch cycles.

3. The method of claim 2, wherein the integer number of pitch cycles is predetermined to be one.

4. The method of claim 1, wherein the transformation function changes a time scale of a residual signal represented by the residual signal frame.

5. The method of claim 4, wherein the transformation function changes the time scale of the residual signal by performing operations that include:

selecting a set of samples from the residual signal, wherein the set of samples is a consecutive sequence of samples taken from the residual signal, such that the set of samples corresponds to a contiguous interval of time in the residual signal;

performing linear interpolation between samples in the first set of samples so as to model the residual signal over said contiguous interval of time as a piecewise linear function; and

generating the modified residual signal by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame.

6. The method of claim 4, wherein the transformation function changes the time scale of the residual signal by performing a non-linear time warping operation on an interval of the residual signal so as to find a correspondence between samples from the interval of the residual signal and samples in a reference signal.

7. The method of claim 6, wherein the non-linear time warping operation is performed according to a dynamic time warping algorithm.

8. The method of claim 1, wherein the transformation function generates a modified residual signal frame from the residual signal frame by performing operations that include:

mapping to zero a first subset of samples from a residual signal represented by the residual signal frame; and

mapping a second subset of samples from the residual signal to their identical values.

9. The method of claim 1, further comprising:

cyclically shifting samples in the modified residual signal frame so as to normalize a phase of the modified residual signal frame.

10. The method of claim 1, further comprising:

feeding the modified residual signal frame to at least one of speech recognition software and speaker recognition software.

11. A computer program product in a computer-readable medium comprising functional descriptive material that, when executed by a computer, causes the computer to perform acts that include:

filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples;

determining from the residual signal frame at least one pitch cycle within the residual frame;

applying a transformation function to the residual frame to obtain a modified residual

frame, wherein the modified residual frame contains an integer number of pitch cycles; and

synthesizing a second speech signal from the modified residual frame and the set of vocal tract model parameters, whereby the second speech signal is a pitch-compensated speech signal.

12. The computer program product of claim 11, wherein the integer number of pitch cycles is a predetermined integer number of pitch cycles.

13. The computer program product of claim 12, wherein the integer number of pitch cycles is predetermined to be one.

14. The computer program product of claim 11, wherein the transformation function changes a time scale of a residual signal represented by the residual signal frame.

15. The computer program product of claim 14, wherein the transformation function changes the time scale of the residual signal by performing operations that include:

selecting a set of samples from the residual signal, wherein the set of samples is a consecutive sequence of samples taken from the residual signal, such that the set of samples corresponds to a contiguous interval of time in the residual signal;

performing linear interpolation between samples in the first set of samples so as to model the residual signal over said contiguous interval of time as a piecewise linear function; and

generating the modified residual signal by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame.

16. The computer program product of claim 14, wherein the transformation function changes the time scale of the residual signal by performing a non-linear time warping operation on an interval of the residual signal so as to find a correspondence between samples from the interval of the residual signal and samples in a reference signal.

17. The computer program product of claim 16, wherein the non-linear time warping operation is performed according to a dynamic time warping algorithm.

18. The computer program product of claim 11, wherein the transformation function generates a modified residual signal frame from the residual signal frame by performing operations that include:

mapping to zero a first subset of samples from a residual signal represented by the residual signal frame; and

mapping a second subset of samples from the residual signal to their identical values.

19. The computer program product of claim 11, comprising additional functional descriptive material that, when executed by the computer, causes the computer to perform additional acts that include:

cyclically shifting samples in the modified residual signal frame so as to normalize a phase of the modified residual signal frame.

20. The computer program product of claim 11, comprising additional functional descriptive material that, when executed by the computer, causes the computer to perform additional acts

that include:

feeding the modified residual signal frame to at least one of speech recognition software and speaker recognition software.

21. A data processing system comprising:

means for filtering a frame of a first speech signal to obtain a residual signal frame and a set of vocal tract model parameters, wherein the frame of the first speech signal and the residual signal frame contain a same fixed number of samples;

means for determining from the residual signal frame at least one pitch cycle within the residual frame;

means for applying a transformation function to the residual frame to obtain a modified residual frame, wherein the modified residual frame contains an integer number of pitch cycles; and

means for synthesizing a second speech signal from the modified residual frame and the set of vocal tract model parameters,

whereby the second speech signal is a pitch-compensated speech signal.

22. The data processing system of claim 21, wherein the integer number of pitch cycles is a predetermined integer number of pitch cycles.

23. The data processing system of claim 22, wherein the integer number of pitch cycles is predetermined to be one.

24. The data processing system of claim 21, wherein the transformation function changes a time scale of a residual signal represented by the residual signal frame.

25. The data processing system of claim 24, wherein the transformation function changes the time scale of the residual signal by performing operations that include:

selecting a set of samples from the residual signal, wherein the set of samples is a consecutive sequence of samples taken from the residual signal, such that the set of samples corresponds to a contiguous interval of time in the residual signal;

performing linear interpolation between samples in the first set of samples so as to model the residual signal over said contiguous interval of time as a piecewise linear function; and

generating the modified residual signal by generating a new sequence of samples from the piecewise linear function such that the cardinality of the new sequence of samples is equal to the same fixed number of samples as contained in the residual signal frame.

26. The data processing system of claim 24, wherein the transformation function changes the time scale of the residual signal by performing a non-linear time warping operation on an interval of the residual signal so as to find a correspondence between samples from the interval of the residual signal and samples in a reference signal.

27. The data processing system of claim 26, wherein the non-linear time warping operation is performed according to a dynamic time warping algorithm.

28. The data processing system of claim 21, wherein the transformation function generates a modified residual signal frame from the residual signal frame by performing operations that include:

mapping to zero a first subset of samples from a residual signal represented by the residual signal frame; and

mapping a second subset of samples from the residual signal to their identical values.

29. The data processing system of claim 21, further comprising:

means for cyclically shifting samples in the modified residual signal frame so as to normalize a phase of the modified residual signal frame.

30. The data processing system of claim 21, further comprising:

means for feeding the modified residual signal frame to at least one of speech recognition software and speaker recognition software.

EVIDENCE APPENDIX

There is no evidence to be presented.

RELATED PROCEEDINGS APPENDIX

There are no related proceedings.